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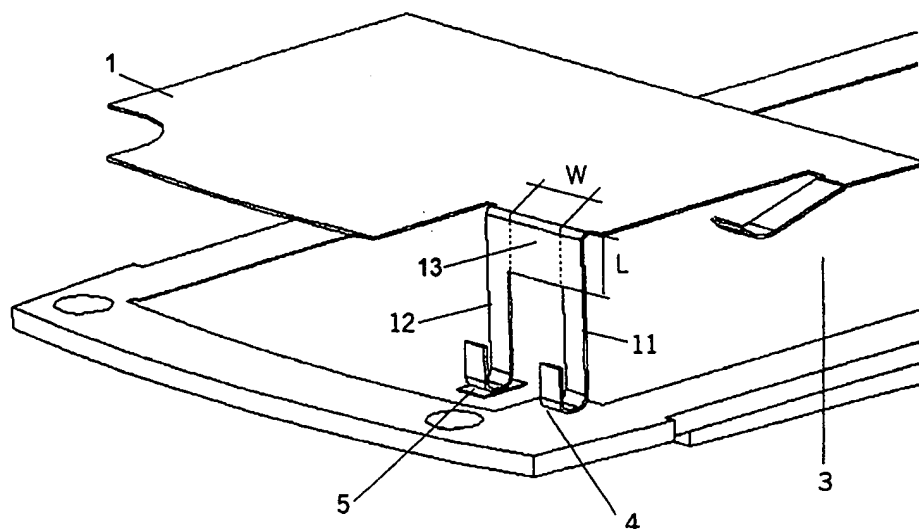
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(54) Title: AN ANTENNA DEVICE AND A COMMUNICATION DEVICE COMPRISING SUCH AN ANTENNA DEVICE



(57) Abstract: The invention relates to a problem with how to achieve a more reliable contact (11, 12) between a radiating element (1) and a PCB (3), in e.g. a portable radio communication device, and how to make a more reliable and simple matching of the radiating element (1). This is obtained by providing integral contacts (11, 12) with the radiating element (1) and securely fastened contacts (11, 12) to the PCB (3), and with a matching element (13) integral with the contacts (11, 12) and the radiating element (1), where its dimensions are changed to achieve a desired matching of the radiating element (1).

WO 01/37369 A1

AN ANTENNA DEVICE AND A COMMUNICATION DEVICE COMPRISING
SUCH AN ANTENNA DEVICE

FIELD OF INVENTION

5 The present invention relates generally to an antenna device comprising a contact between a radiating element and a Printed Circuit Board (PCB), wherein the contact also is used to match the radiating element. The present invention relates more specifically to integral
10 contacts on an internal antenna in a portable radio communication device, for connecting the antenna to a PCB, and for matching the antenna.

BACKGROUND

It is previously known to use integral contacts of an
15 internal antenna. This is made to lessen the number of unreliable contact points in an electronic transmission system. However, the characteristics of a thin and unsupported contact can change if it is carelessly treated. A problem with known integral contacts is thus
20 that they still are unreliable and sensitive to careless treatment.

It is previously known to impedance match an internal antenna. It is desirable to have as few components as possible involved in the matching of an antenna to facilitate the matching, and to lessen the number of components that can change with the course of time and thereby deteriorate the matching. A problem with known
25 matching is the sensitivity to careless treatment and the difficulty to match an antenna in an easy way.

30 From US 5,907,817 it is previously known to provide a contact between an antenna and a PCB. Even though the

antenna is disclosed as an internal antenna it is in fact an external fixed antenna. A problem with this contact is that it has an unnecessary number of contact points, and it is not suitable for matching.

- 5 From US 5,731,791 it is previously known to provide a contact between an external (fixed) antenna and a PCB. A problem with this contact is that it has an unnecessary number of contact points, and it is not suitable for matching.
- 10 From US 5,929,812 it is previously known to provide two integral contacts of an internal antenna, wherein one contact is connected to a separate ground plane and the other contact is connected through an electrical connector to a PCB. A problem with this contact is that it
- 15 does not provide a reliable connection due to the lack of proper connecting force and it is not shown how to use the contact for matching the antenna.

- From EP 0 867 967 A2 it is previously known to provide two integral contacts of an internal antenna, wherein
- 20 one contact is connected to a separate ground plane and the other contact is a feed element. To electrically adapt the feed element, a stepped metal strip is used, wherein the length of the steps and the width of the strip depend on desired electrical operation. A separate capacitance is used for matching. A problem with
- 25 this contact is that it is not a reliable contact and it is not shown how to solely use the contact for matching the antenna.

OBJECTS OF THE INVENTION

An object of the present invention is to facilitate electrical matching of an antenna.

A further object of the present invention is to make a
5 more reliable and durable electrical matching of the antenna.

A still further object of the present invention is to facilitate the manufacture and assembly of an antenna contact element.

10 SUMMARY OF THE INVENTION

According to the present invention there is provided an antenna device as claimed in claim 1.

An advantage compared to prior art is obtained as both the ground portion and the feed portion of the antenna
15 device are directly connected to the PCB.

Other advantages are obtained through the features of the depended claims and will be evident from the following description of embodiments given by way of examples with reference to the enclosed drawings.

20 BRIEF DESCRIPTION OF DRAWINGS

The invention is now described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 shows how a matching element between two integral contact legs can be adapted to match an internal
25 antenna,

Fig. 2 shows an exploded view of the antenna device according to the invention,

Fig. 3 shows how the legs are supported and maintained in position,

Fig. 4 shows an exploded view of a portable radio communication device with an inventive antenna device, and

5 Fig. 5 shows an alternative matching element pattern.

DETAILED DESCRIPTION OF THE INVENTION

An embodiment of the invention comprised in a reliable and robust portable radio communication device, e.g. a mobile or portable telephone, will now be described
10 with reference to Fig. 1. Regarding this disclosure, it is to be understood that the radiating element of the invention is operable to transmit and/or receive RF signals. It is also to be understood that the matching of the invention is an impedance matching.

15 A connection between a radiating element 1, e.g. a Planar Inverted F Antenna (PIFA), sheet metal or flex film, and a PCB 3 consists of two legs with a matching element 13 there between. The matching element 13 is integral with legs 11, 12 and the radiating element 1.
20 The dimensions of the matching element 13 comprise its length L and width W.

The legs 11, 12 are of equal width and consist of a grounding element 11 and a feeding element 12. The legs are in one end an integral part of the radiating element 1 and are manufactured as one piece and then
25 folded to fit in with an antenna frame 2, see Figs. 2 and 3. The other ends of the legs are free and folded to be clamped between the antenna frame and the PCB 3. The PCB 3 comprises RF receiver/transmitter electronics

and the ground portion thereof functions as the ground plane of the antenna.

The length L and/or the width W of the matching element 13 can be varied to match the radiating element 1. This provides a matching element 13 between the legs 11, 12 that further mechanically stabilizes the legs. This also facilitates manufacturing and mounting of the antenna in the portable radio communication device.

The antenna frame 2 is used to support the legs 11, 12 as shown in Figs. 2 and 3. The antenna frame 2 supports the radiating element 1 and the legs 11, 12, where the legs 11, 12 are generally perpendicular to the radiating element 1. The antenna frame 2 also supports the folded free ends of the legs 11, 12. The legs are connected to contact points 4, 5 on the PCB 3, see Fig. 1, by means of this support. With the legs 11, 12 integral with the radiating element 1 and supported by the antenna frame 2 and clamped between the antenna frame 2 and the PCB, a well defined high precision high contact pressure is achieved.

In figure 4 there is shown a portable radio communication device in the form of a mobile phone. The mobile phone comprises an inventive antenna device comprising a first fixed radiating element, generally designated 1, arranged to be used built into the mobile phone. The internal element 1 comprises a generally flat conducting patch portion, shaped so as to provide desired radiating characteristics for the application in question. As already stated, in the preferred embodiment, the inbuilt element 1 is a part of a Planar Inverted F

Antenna (PIFA). The radiating element 1 is positioned between the antenna frame 2 and the PCB 3.

To clamp the free ends of the contacts 11, 12 between the antenna frame and the PCB a screw 14, and preferably an existing screw used to put together the portable radio communication device, is used. The free ends of the contacts 11, 12 are clamped to the contact points 4, 5, see Fig 1, on the PCB 3.

According to the embodiment described above a more reliable connection between an internal antenna and a PCB in a portable radio communication device, such as a mobile or portable telephone, is achieved, wherein a contact is an integral part of the internal antenna and supported by a frame that keeps the contact in a fixed position and connected to the PCB by e.g. screws that press the contact to the PCB. Thus, the contact comprises two legs with a slit there between.

A simple and more reliable matching of the antenna is achieved, wherein the shape, such as length and/or width of the matching element is varied, instead of as in prior art where a feed element could be changed to form e.g. a stepped strip. This makes the connection between the antenna and the PCB more stable and reliable, and there are no external electric variables to take into consideration during matching. There are no components that change with time, and therefore the matching is independent of time of use, less dependent of the environment and the physical treatment of the portable radio communication device.

An alternative matching circuit is a bridge 13', see figure 5, between the legs 11, 12. The bridge is integral with both legs, but has no direct conductive connection to the radiating element 1. Besides functioning
5 as a matching element, the bridge 13' also functions to mechanically stabilize the leg arrangement.

Preferred embodiments have been described. It is realized that they may be varied within the scope of the appended claims. Thus, the ground leg 11 can be made
10 wider than the feed element 12, or narrower than the feed element 12. The folded free part of the ground leg 11 can have several contact points to the PCB. An alternative way to get several contact points to the PCB is to use several ground legs.

15 The position of the legs 11, 12 can also be used to tune the radiating element 1 to a desired frequency. The distance between the legs changes the tuning of the radiating element 1.

Screws have been shown as the preferred means for holding the communication device together. There are also
20 other possible means, such as welding or a snap function.

The radiating element 1 has been shown with a specific shape. It is realized that it can have any suitable
25 shape adapted for the specific requirements on the antenna element in question. Thus, although the radiating element 1 has been shown with a generally planar shape, it is realized that it can be slightly arched, thereby being adapted to the overall shape of the cover in
30 which the antenna device is mounted.

CLAIMS

1. An antenna device for a portable radio communication
5 device comprising:

- a support structure (2),
- a generally planar radiating element (1) supported
by said support structure (2), and
- at least a first conductive leg (11) being connect-
10 able to a ground plane device and a second conduc-
tive leg (12) being connectable to a feed device,
each of said legs being supported by the support
structure (2) and in a first end being connected
with said radiating element (1)

15 **characterized by**

- a matching element (13) being connected between said
at least first leg (11) and second leg (12), wherein
said matching element (13) being adapted to provide
a desired impedance matching of said radiating
20 element (1).

2. The antenna device according to claim 1, wherein
said at least first leg (11) and second leg (12) are
integral with said radiating element (1).

3. The antenna device according to claim 2, wherein
25 said matching element (13) being integral with said at
least first leg (11) and second leg (12).

4. The antenna device according to claims 1 or 2,
wherein said matching element (13) being integral with

said radiating element (1) and said at least first leg (11) and second leg (12).

5 5. The antenna device according to any of claims 1 to 4, wherein a length (L) of said matching element (13) is adapted to provide the desired matching of said radiating element (1).

6. The antenna device according to any of claims 1 to 4, wherein a width (W) of said matching element (13) between said legs is adapted to provide a desired
10 matching of said radiating element (1).

7. The antenna device according to claims 5 or 6, wherein the length (L) and the width (W) of said matching element (13) are adapted to provide the desired matching of said radiating element (1).

15 8. The antenna device according to any of the preceding claims, wherein a connected bridge (13') is arranged between the legs (11, 12) and adapted to provide a desired matching of said radiating element (1).

9. The antenna device according to any of the preceding
20 claims, wherein said matching element (13) is the sole component for matching of said radiating element (1).

10. The antenna device according to any of the preceding claims, having a PCB (3) functioning as said ground plane device.

25 11. The antenna device according to any of the preceding claims, wherein said at least first leg (11) and second leg (12) are clamped in a second end.

12. The antenna device according to claim 11, wherein said second ends are folded to fit in with the support structure (2).

13. The antenna device according to claim 11 or 12,
5 wherein the second ends of said first leg (11) and second leg (12) are clamped between said antenna frame (2) and said ground plane device.

14. The antenna device according to claims 11-13,
wherein a fastening device is used to clamp said at
10 least first leg (11) and second leg (12).

15. The antenna device according to claim 14, wherein a screw (14) is used to clamp said at least two legs (11, 12) and preferably an existing screw (14) used to put together the portable radio communication device.

16. The antenna device according to claim 1, wherein
15 said at least first leg is a ground element (11) and said second leg is a feed element (12).

17. The antenna device according to claim 16, wherein
the ground element (11) is wider than the feed element
20 (12).

18. The antenna device according to claim 16, wherein
the ground element (11) is narrower than the feed element (12).

19. The antenna device according to any of claims 16 -
25 18, wherein the second end of the ground element (11) is provided with several contact points to said ground plane device.

20. The antenna device according to claims 17 or 19, wherein the ground element (11) is wider than the feed element (12) and is provided with several contact points to said ground plane device.

- 5 21. The antenna device according to claims 18 or 19, wherein the ground element (11) is narrower than the feed element (12) and is provided with several contact points to said ground plane device.

- 10 22. The antenna device according to any of the preceding claims, wherein further ground elements are provided to achieve several contact points to said ground plane device.

- 15 23. The antenna device according to any of the preceding claims, wherein the portable radio communication device is a mobile or portable telephone.

24. The antenna device according to any of the preceding claims, wherein the legs (11, 12) being essentially perpendicular to the plane of the radiating element (1).

- 20 25. The antenna device according to any of the preceding claims, wherein said generally planar radiating element (1) is part of a planar inverted F antenna.

- 25 26. A portable radio communication device comprising an antenna device according to any of the preceding claims.

1/3

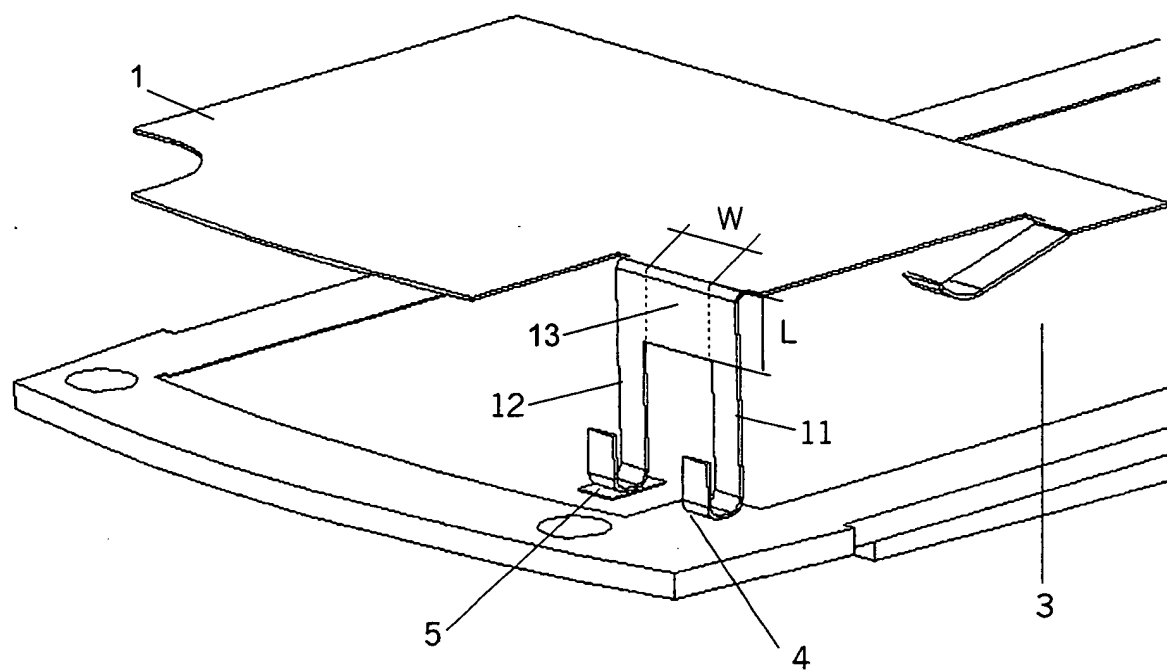


Fig 1

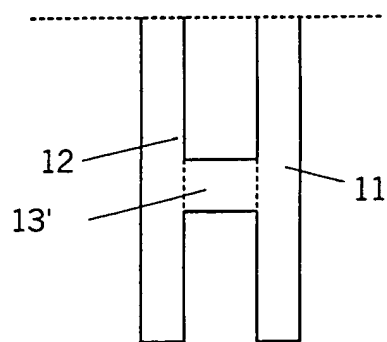


Fig 5

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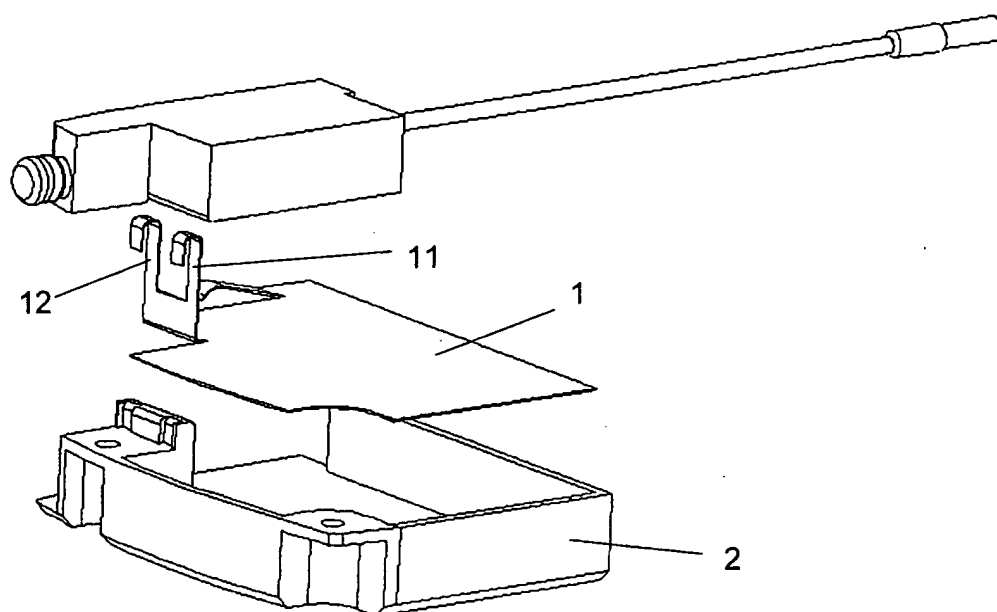


Fig 2

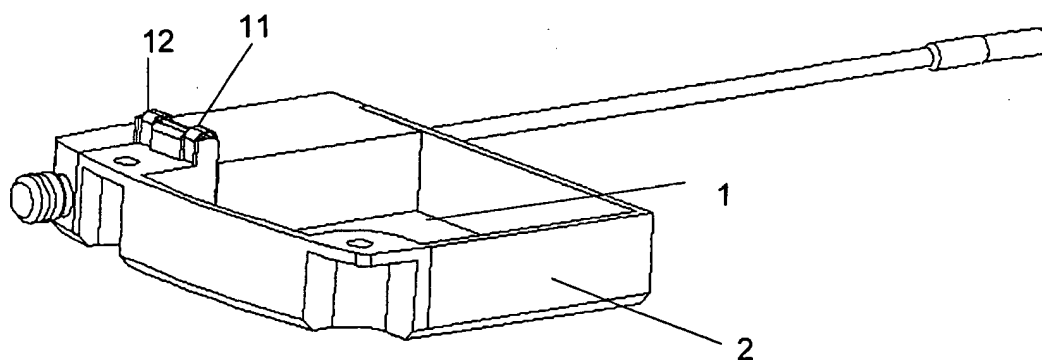


Fig 3

3/3

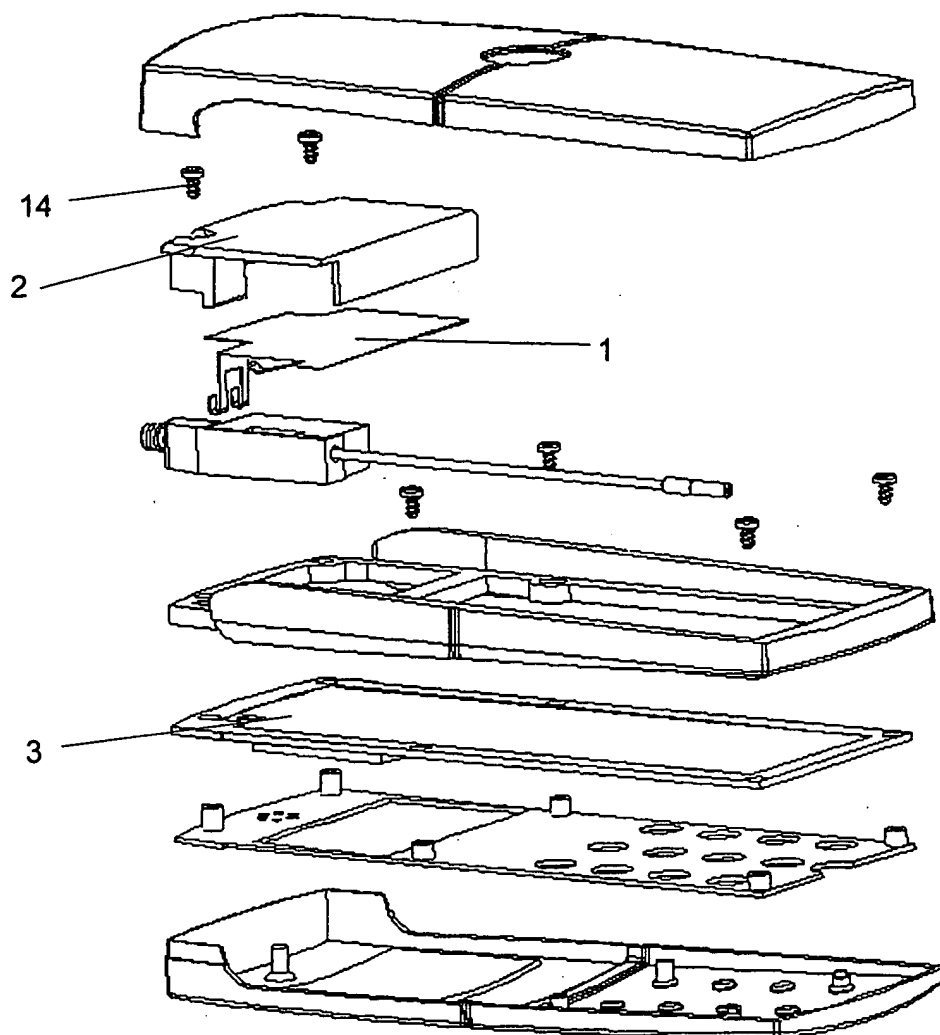


Fig 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/02004

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H01Q 1/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P, A	WO 0003452 A1 (TELEFONAKTIEBOLAGET LM ERICSSON), 20 January 2000 (20.01.00) --	1-26
A	EP 0856907 A1 (LUCENT TECHNOLOGIES INC.), 5 August 1998 (05.08.98) --	1-26
A	GB 2316540 A (NEC CORPORATION), 25 February 1998 (25.02.98) --	1-26
A	US 5929812 A (AMINZADEH), 27 July 1999 (27.07.99) --	1-26

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 00/02004

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0867967 A2 (NOKIA MOBILE PHONES LTD.), 30 Sept 1998 (30.09.98) -- -----	1-26

INTERNATIONAL SEARCH REPORT

Information on patent family members

27/12/00

International application No.

PCT/SE 00/02004

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